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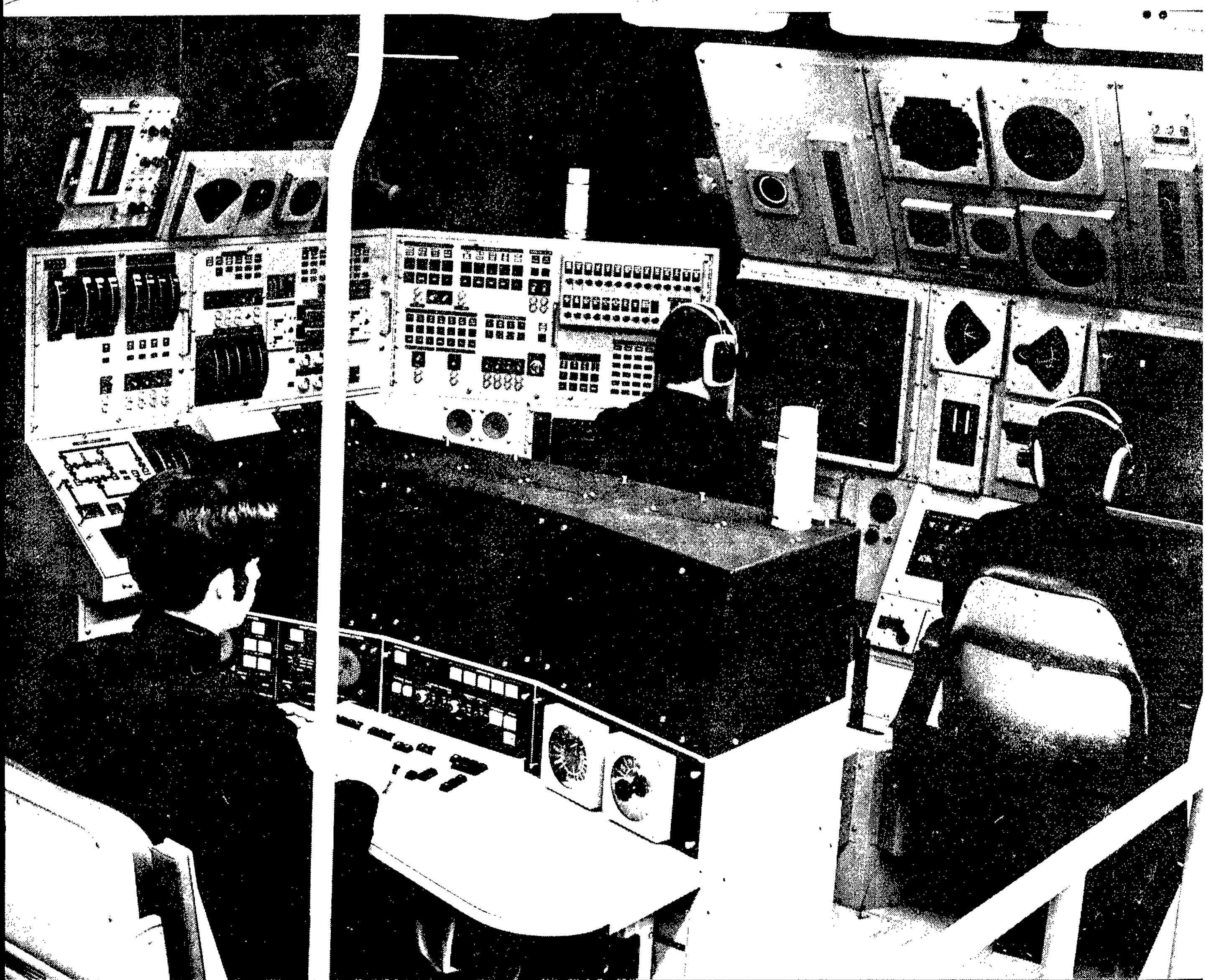

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TRAINING DEVICES DISCUSSED HEREIN ARE NOT NECESSARILY AVAILABLE FOR DISTRIBUTION TO FIELD ACTIVITIES AT THIS TIME.

Captain T. H. Nugent, Jr.
Commanding Officer
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Charles T. Bourne
Editor

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NOTE FOR US AIR FORCE READERS. Information concerning training devices of interest to the Air Force may be obtained by contacting: Air Force Liaison Officer, Naval Training Equipment Center, Orlando, FL 32813. Telephone (Autovon) 791-4193; or (Commercial) 305-646-4193.

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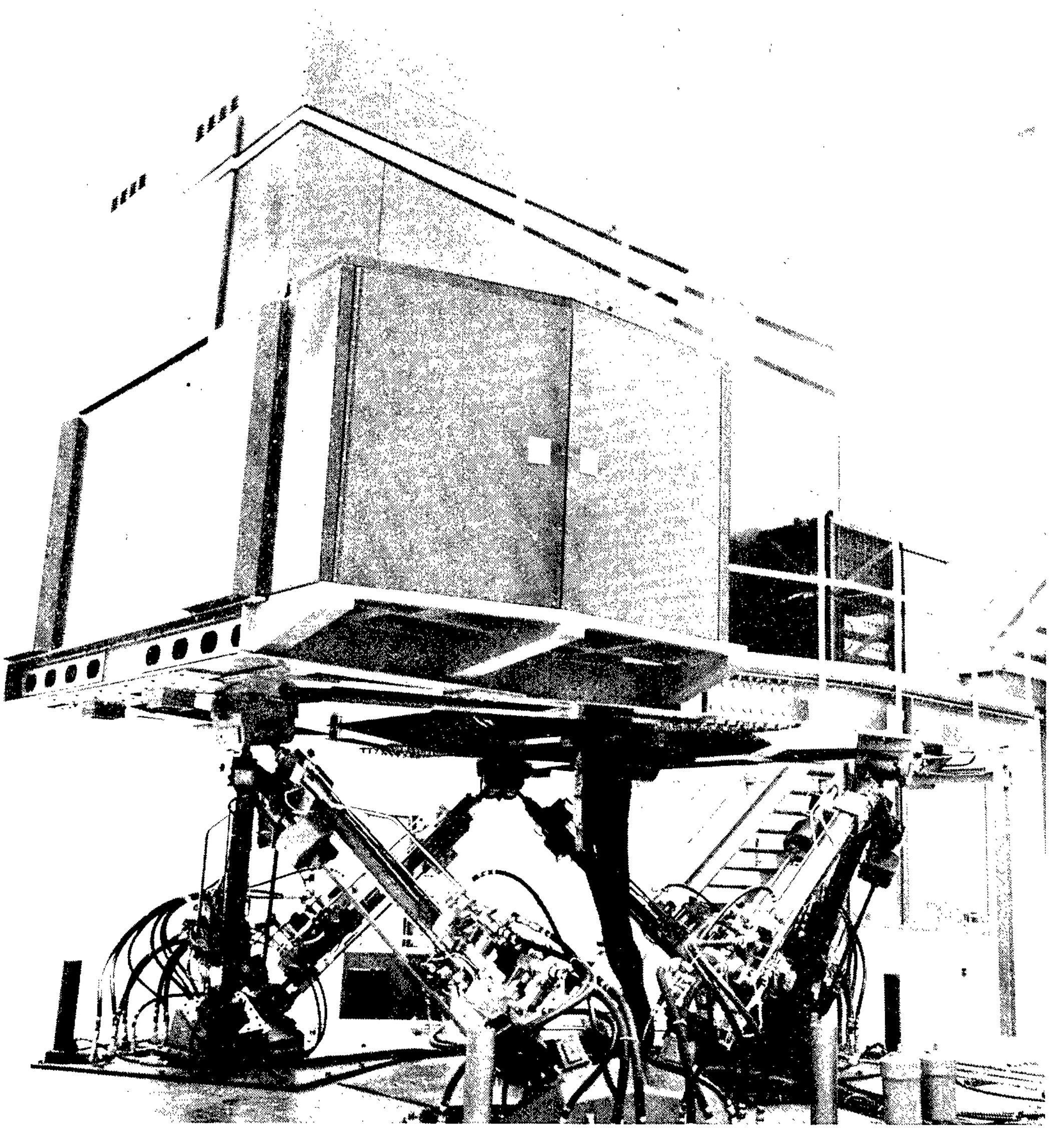
Major Training Devices

CH-47C Flight Simulator
Device 2B31

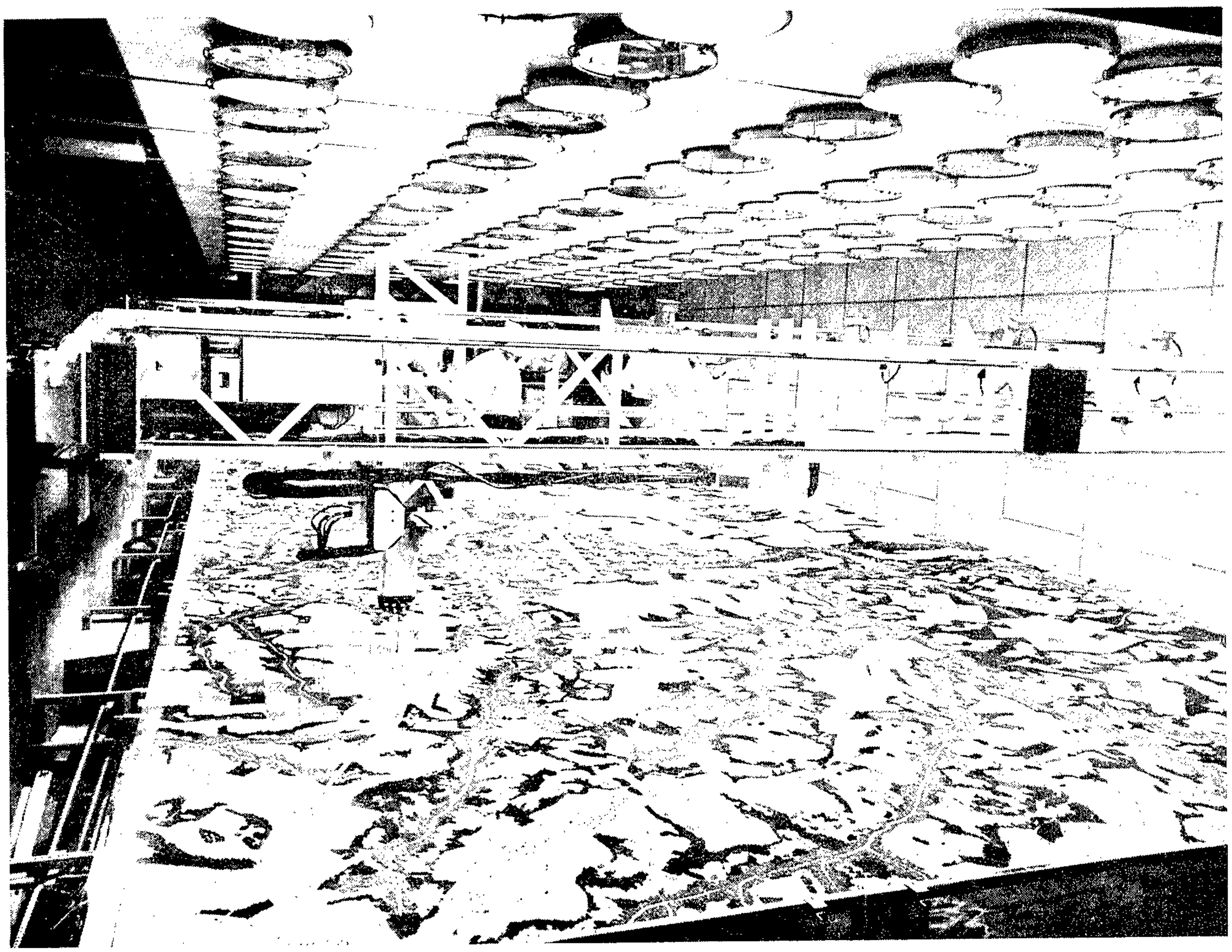
By Paul S. Walker, Project Director
US Army Project Manager for Training Devices



Motion System and Cockpit/Instructor Area

The Army's most sophisticated flight simulator, Device 2B31, has been accepted at Fort Rucker, Alabama. Modeled after the CH-47C medium cargo helicopter, it is designed for use in the initial transition training and subsequent proficiency training for CH-47C aviators. The simulator is currently undergoing operational testing to determine to what degree it can be used to augment or replace existing training programs. Test subjects will include 24 aviators undergoing initial transition training into the CH-47C, and an additional 16 CH-47C qualified aviators using the simulator for proficiency training purposes. The test program began in January 1977 and will be completed in August 1977.

The simulator consists of a single cockpit representing the CH-47C cockpit from the nose of the aircraft to a point just aft of the pilot and copilot stations. The instructor station is mounted in the cockpit section behind the copilot seat. The entire cockpit is mounted upon a six degree of freedom motion system and is stimulated by a DEC PDP 11/45 computer system. Two types of visual presentations are provided. A high resolution 48° x 36° virtual image television production scene is presented through the front windows at the pilot and copilot stations simultaneously. This scene is identical for each station except that perspective is correct only for the station of the pilot in control of the simulator.

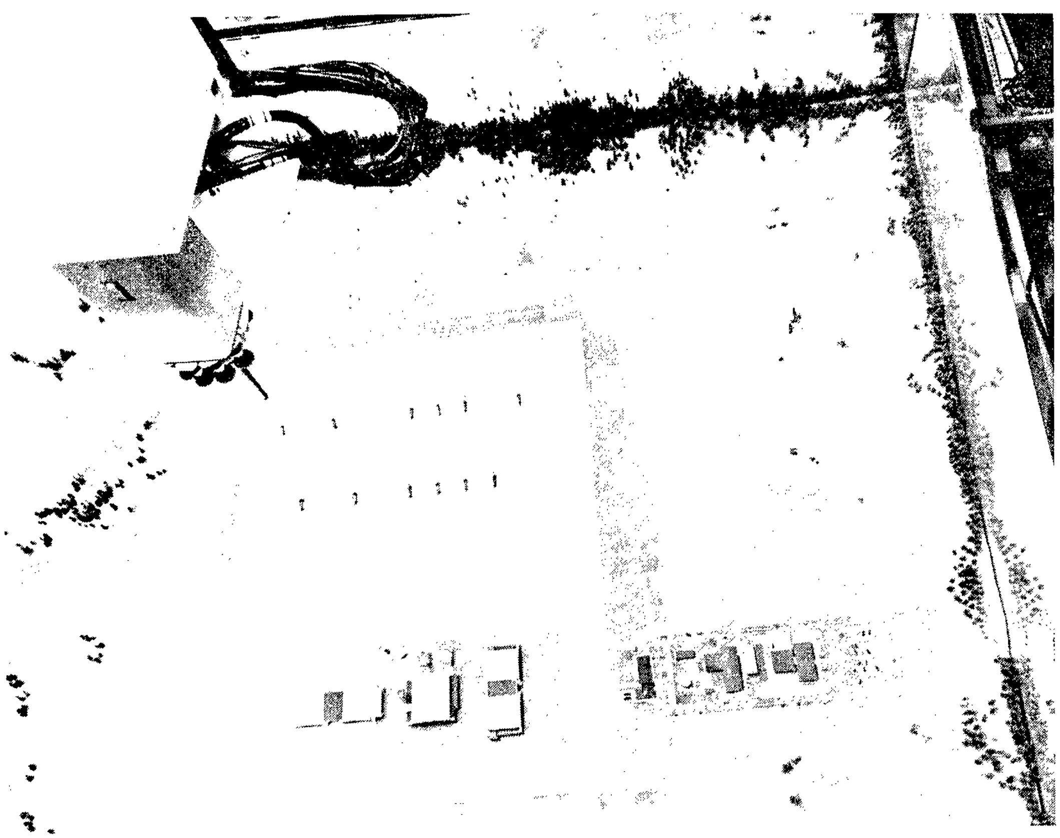


View of Major Part of Modelboard Including Probe, Light Bank, and Gantry.

A computer generated imagery scene is also presented through the simulated **chin** windows. This scene is a checkerboard pattern designed to assist the trainees in performing landing, taxiing, hovering, or takeoff maneuvers. The squares of the checkerboard change size to indicate variations in altitude. Movement of the squares horizontally provides velocity and directional motion cues. The modelboard which generates the scene for the front window visual systems measures 24′ x 56′ and depicts a generalized terrain area representative of that found in southeastern Alabama. One panel of the modelboard is at a scale of 400:1 and serves as the principal area for teaching taxiing and hovering maneuvers. The remainder of the modelboard is at a scale of 1500:1 and includes a modern stagefield, confined landing areas, and a pinnacle landing area. The modelboard area is sufficiently large to support training in terrain flight (nap of the earth) techniques. The entire simulator is housed in a specificially designed building at Fort Rucker.

Device 2B31 represents a major step forward in helicopter flight simulation. Designed and built under contract for the Army by the Singer Company, Link Division, Binghamton, New York, it is capable of providing training in the performance of all normal operating requirements with the exception of slope landings and water landings. Included in the system, are 10 demonstration programs which show in detail the proper techniques of performing the basic maneuvers required of the students. In addition, there are two automated check rides: one for VFR flight and one for IFR flight. All information and controls necessary for the instructor are provided at his station, directly behind the trainees. There are 200 separate malfunctions that can occur automatically in response to aircraft conditions or that can be initiated at the instructor's desire.

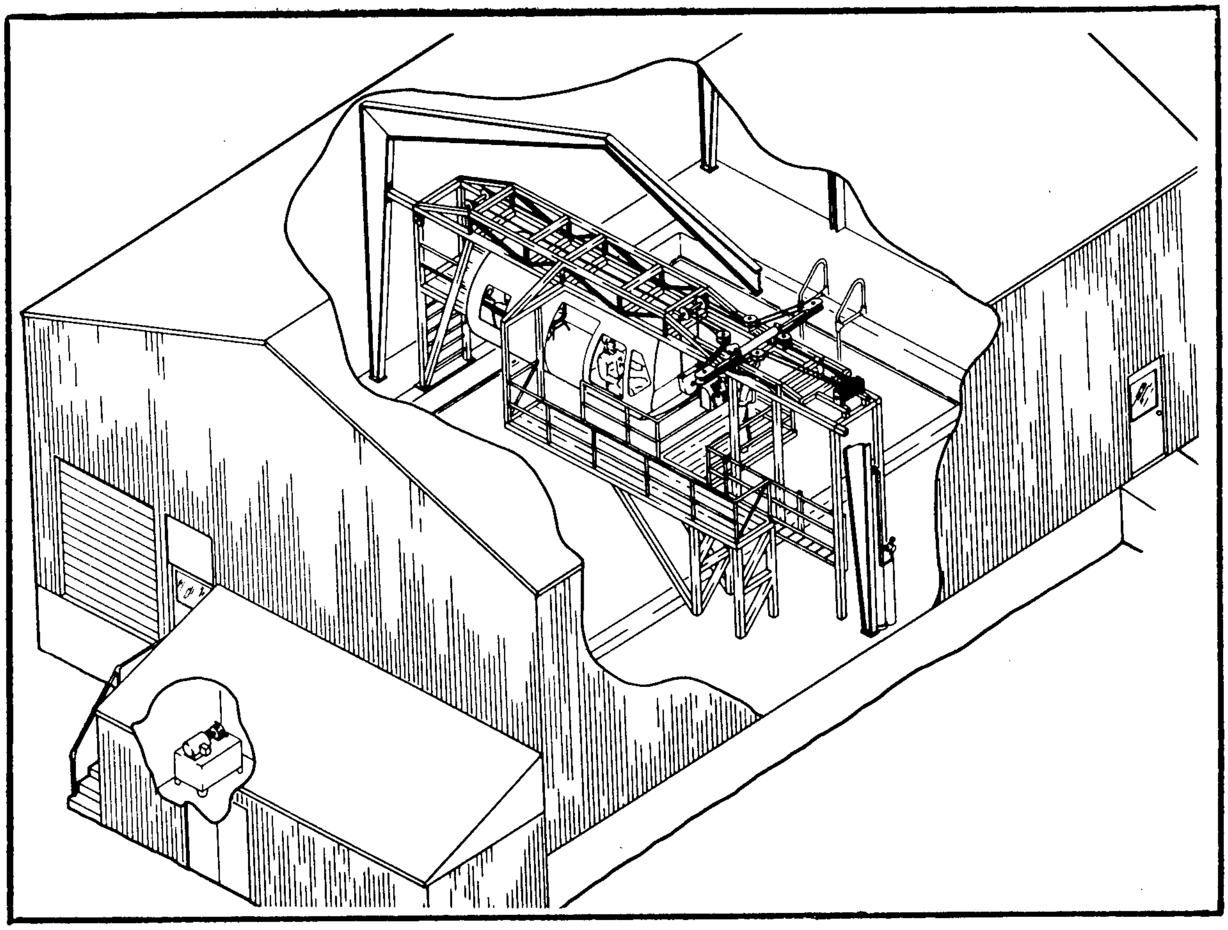
The simulator is being maintained by contractor personnel through a modification of the Army's UH-1H Flight Simulator worldwide maintenance contract. This contract is supervised by the US Army Aviation Systems Command, St. Louis, Missouri. Current utilization rate is 16 operating hours per day, five days per week. Initial operating costs have been computed at $87 per flying hour as compared to $1,001 per flying hour for the actual aircraft.



View of Hanchey Army Heliport at Fort Rucker.

Universal Helicopter Underwater Escape Trainer Device 9D5

By Ben Rosenbaum, Project Engineer
Special Systems Branch



Cutaway of Device 9D5

The Universal Helicopter Underwater Escape Trainer, Device 9D5, is intended to accomplish what its name implies, train pilots and passengers in escape procedures from a helicopter forced to ditch in water. Installation was completed at the Naval Aviation Schools Command, Pensacola, Florida, in March 1977 and underwent Government acceptance tests with live passengers in April.

The 9D5 as a **situation** trainer will familiarize aircrewmen and passengers with escape procedures from a ditched helicopter. It is not intended to simulate any particular helicopter but instead is considered to be a composite of all Navy and Marine Corps helicopter types. This is partly accomplished by utilization of a universal-type hatch release mechanism. By prepositioning the mechanism properly in the fuselage and using the proper lockout pins, it is possible to simulate any required hatch release movement (i.e., pull up, push down, push forward, pull back, etc.).

The 9D5 consists of a fiberglass cylinder fuselage, complete with simulated cockpit controls and fiberglass seats, suspended by cables from a stainless steel support structure. The support structure spans the width of a 24′ x 34′ x 15′ swim tank, contains the hydraulic up/down winches and roll actuators, and supports one end of the loading platform in addition to the operator's station. The 2,000 psi hydraulic power supply is located in an adjoining pump room.

Device 9D5 lowers the fuselage loaded with four occupants at a controlled descent rate from the uplock position to the water surface and then continues its descent or roll a maximum of 180° right or left until completely submerged. Two trainees may ride in the cockpit or all four may ride in the passenger compartment. Escape is via open windows and doorway. Prior to escape, the trainee will be required to release his seat belt, operate the hatch release mechanism, and move a slide bar above the exit, simulating the required operations to remove a window or door from a real helicopter. A number of safety features have been incorporated into the device. An independent emergency system will retract the fuselage and occupants to the water surface in less than 10 seconds from any attitude. An emergency airhorn will signal divers and trainees that emergency retraction will take place. During normal training, 20 training cycles will be completed per hour. Divers will be in the water to assist in the event of escape problems.

The importance of Device 9D5 can be realized from Naval Safety Center records which show that during the period July 1963 to February 1975 234 helicopters with 1,093 occupants ditched or crashed in water. Almost half of the survivors were forced to escape from a submerged position. The success rate of survival was 91.5 percent for those trained in underwater escape while the success rate for those who had not been trained was only 66 percent. The low survivability rate highlights the need for an underwater escape trainer designed not only for aviators but also for helicopter passengers. Major problems encountered by survivors were: inrushing water, disorientation, panic, confusion, entanglement with debris, and unfamiliarity with hatch release mechanisms. Difficulty in operating release mechanisms has frequently been encountered during actual underwater escape. Among the most widely deployed Navy helicopters (H-2, H-3, H-46), there are 15 different types of external rescue handles.

Further statistical backing for the need of underwater escape training can be found in the Royal Navy, which has been utilizing an underwater helicopter escape trainer since 1962. Since the inception of the trainer, drowning fatalities resulting from ditching have been almost eliminated. The training is mandatory for all aircrews and is repeated at two-year intervals. Aircrews ride the trainer from different seat positions, thoroughly gaining confidence in their ability to successfully escape from anywhere in the helicopter. Their training reflects the belief that successful escape from a ditched/sinking helicopter depends largely on a spontaneous action achieved through repetitive drills. The results tend to prove this hypothesis.

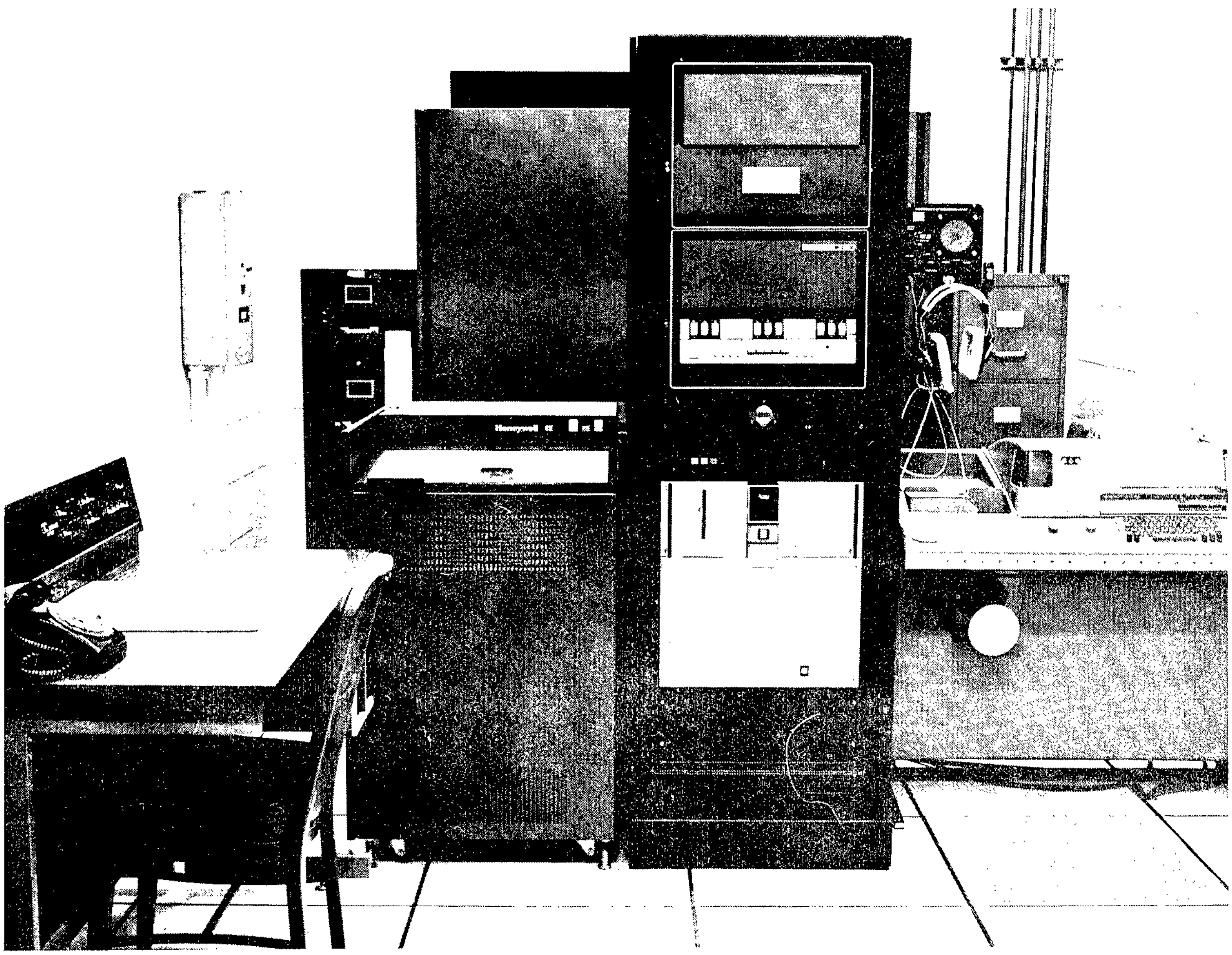
The Universal Helicopter Underwater Escape Trainer will augment present water survival training. Eventually all aviation personnel, regardless of the type of aircraft flown, will be required to receive escape training in Device 9D5. In addition, personnel who may have frequent occasions to ride in helicopters will also be required to receive this training.

Navy helicopter aircrews operate from virtually all types of ships and are tasked with round-the-clock search and rescue, ASW support, night medical evacuations, and passenger flights. This extended overwater activity subjects aircraft and passengers to potential overwater emergencies and subsequent ditching. Overwater, immediate action emergencies necessitate ditching for helicopter aircrews, while fixed-wing aircrews experiencing similar emergencies have the option of ejection/bailout.

Device 9D5 was built under contract for Naval Training Equipment Center by Burtek, Inc., of Tulsa, Oklahoma. Following evaluation of the first trainer, additional units are anticipated for NAS Jacksonville, Florida; Naval Regional Medical Centers at San Diego, California and Portsmouth, New Hampshire; and Marine Corps Air Stations at Cherry Point, North Carolina, and El Toro, California.

Multiclass Advanced Submerged Ship Control Trainer Device 21C7

By Charles R. Sanders, Acquisition Director
Subsurface Systems Branch



Computer and Peripherals

A Multiclass Advanced Submerged Ship Control Trainer, Device 21C7, has been designed to train submarine personnel in advanced emergency ship control procedures necessary to recover a nuclear submarine from casualty conditions incurred while engaged in all modes of operation and at any depth. The device will be used in homeports and overhaul sites of nuclear submarines as a means of implementing a program in initial, refresher, and advanced training in submarine casualty control for crews in upkeep, overhaul, and off-crew status. It will also be used as part of a training program designed to reach and maintain an established level of proficiency in the skills required for casualty control.

The conventional approach has been to train a submarine crew on a simulator built for its particular class vessel. Because of the proliferation of classes and the stationing of these classes at widely separated homeports, many crews no longer have access to the training device built for their class ship. Research was conducted under contract by the Naval Training Equipment Center's Human Factors Laboratory to investigate the feasibility of a generalized training device for advanced casualty control. The results of this study, documented in NAVTRADEVCEN Technical Report 69-C-0117 (Vols. I & II), A Study of a Generalized Advanced Casualty Ship Control Training Device, August 1970, determined that a generalized device was feasible and the study derived the composite requirements for all classes of nuclear attack and ballistic missile submarines. These composite requirements were used in the study as the basis for determining the specific functional characteristics and generalized configuration for a multiclass training device.

The results of the study were utilized to design Device 21C7. The trainer cab is a generalized configuration representing the ship control stations on both SSN/SSBN classes of submarines. Although the trainer cab is generalized, the equations of motion programmed into the digital computer cause the trainer to react physically in a manner which accurately simulates the at-sea motion of that particular class of submarine.

The mission of the device is to provide training in steering, diving, air and hydraulic manifolds, trim system, ballast control, and emergency recovery operations. Controlled learning situations may range from basic familiarization and simple ship maneuvering through complex flooding casualties with their associated compensation problems. Simulation is in the form of physical feel and visual indications. Trainees experience movement in response to changing planes, angles, and ballast conditions.

A semienclosed platform, gimbal-mounted to simulate pitch and roll, has an instrumented ship control station. It has provisions for interchanging several subpanels to provide a better configuration fit for individual classes of submarines. The trainer reproduces the internal environment by activating all equipment that indicates maneuvers from surface to collapse depth. The trainer can simulate external environments such as surface effects, near surface effects, wave action, and bathythermal effects. The ballast control panel permits simulated operation of trim, list, diving, surfacing, and all ship's auxiliary systems with realistic override provisions. All controls, including emergency helm, reflect characteristic forces and kinesthetic feel of operational equipment. Platform motion has a pitch angle range of $\pm 45°$ and a roll angle range of $\pm 30°$.

The computer equipment consists of a Honeywell H-316 general-purpose digital computer programmed in real-time, a real-time interface, CRT controller, disc storage, paper tape read/punch, and teletypewriter.

The instructor station is located on the motion platform overlooking the ship control station. The instructor may establish an infinite variety of problems. External and internal environments are controlled and monitored by the instructor who may **freeze** the trainer at any point for instructional purposes. The instructor console contains a CRT display system which is interfaced with the digital computer. The display system consists of three CRT monitors and permits the instructor to monitor initial conditions, ship control panel, and ballast control panel indicators, malfunction status, and graphic displays (x-y plots) of ship conditions. The instructor may insert malfunctions or flooding casualties and vary the seastate to convert an operational problem into a controlled learning situation.

The first unit of Device 21C7, built under contract for the Naval Training Equipment Center by Hydrosystems, Incorporated, Farmingdale, New York, is operational at Naval Submarine School, Groton, Connecticut. Additional units will be operational in the near future at Fleet Ballistic Missile Submarine Training Center, Charleston, South Carolina; Fleet ASW Training Center, Norfolk, Virginia; Naval Submarine Training Center (Pacific) Detachment, San Diego, California; and Naval Submarine Training Center (Pacific), Pearl Harbor, Hawaii.

Generalized Individual Fire Control Operator Trainer Device 21B63

By Frank Gegunde, Acquisition Director
Subsurface Systems Branch

Trainee Stations, Device 21B63

The latest development in instructional technology for the training of underwater fire control system operators is now operational at the Naval Submarine School, Groton, Connecticut. The Generalized Individual Fire Control Operator Trainer, Device 21B63, features training of operator personnel with computer-aided, audiovisual, and interactive techniques.

Device 21B63 provides realistic hands-on training for target localization, weapon presetting, and other fire control system functions. It consists of operational MK 113 MOD 10 fire control system equipment, including the dual bay AN/UYK-7 computer, RD-281 disk drive, 1532 input/output console, six operational MK 81 weapon control consoles, and the fire control system operational software program.

Coresident with the operational software program is the specially developed training software program, which provides the numerous instructional features of Device 21B63. This training program, the heart of Device 21B63, provides for complete operator training on the MK 81 weapon control console through two training modes: a computer-aided training (CAT) mode and a dynamic exercise (DE) mode.

The CAT mode was developed for teaching students the basic fire control system principles and operational procedures. Each CAT exercise consists of a sequence of prerecorded text and console displays replayed on the MK 81, accompanied by synchronized narration which provides audio explanation.

During a CAT exercise, students are requested by the accompanying narration to perform console switch operations as though actually on-line to the fire control program. When the student responds, he is given visual evaluation (correct or incorrect) of the action on his console display. In addition, the instructor is automatically provided with a hard copy record of student errors. Conduct of a CAT exercise is analogous to a tutorial session whereby the student sits at the MK 81 console viewing the console's display while the instructor provides explanatory commentary of the data displayed and system operation.

The DE mode of Device 21B63 provides the student with a direct interface with the fire control system and allows him to develop the operational knowledge obtained in the CAT exercises into real-life tactical experience. The DE mode accomplishes this through ownship, target, sensor, and weapon simulation which gives the instructor the capability of setting any realistic tactical scenario into the trainer. During a dynamic exercise, the student acts as though actually on board ship with target contacts and performs all fire control system operations to obtain target motion analysis (TMA) solutions (the target's bearing, course, speed, and range values). He can also deploy a simulated weapon and observe the hit. During dynamic exercises, in addition to being able to monitor each student console from the instructor console, the instructor is provided with a hard copy printout of the student's TMA solution evaluations and the results of weapon deployment. At the conclusion of the DE, the instructor can also elect to replay student displays recorded during the exercise for an interactive critique session, at which time the tactical situation and student performances can be discussed in detail.

Although Device 21B63 provides extensive instructional capabilities, no computer programming is required to operate the trainer or to generate the CAT and dynamic exercises. In addition, course preparation time has been reduced since the CAT exercises are preprogrammed and the dynamic exercises are stored.

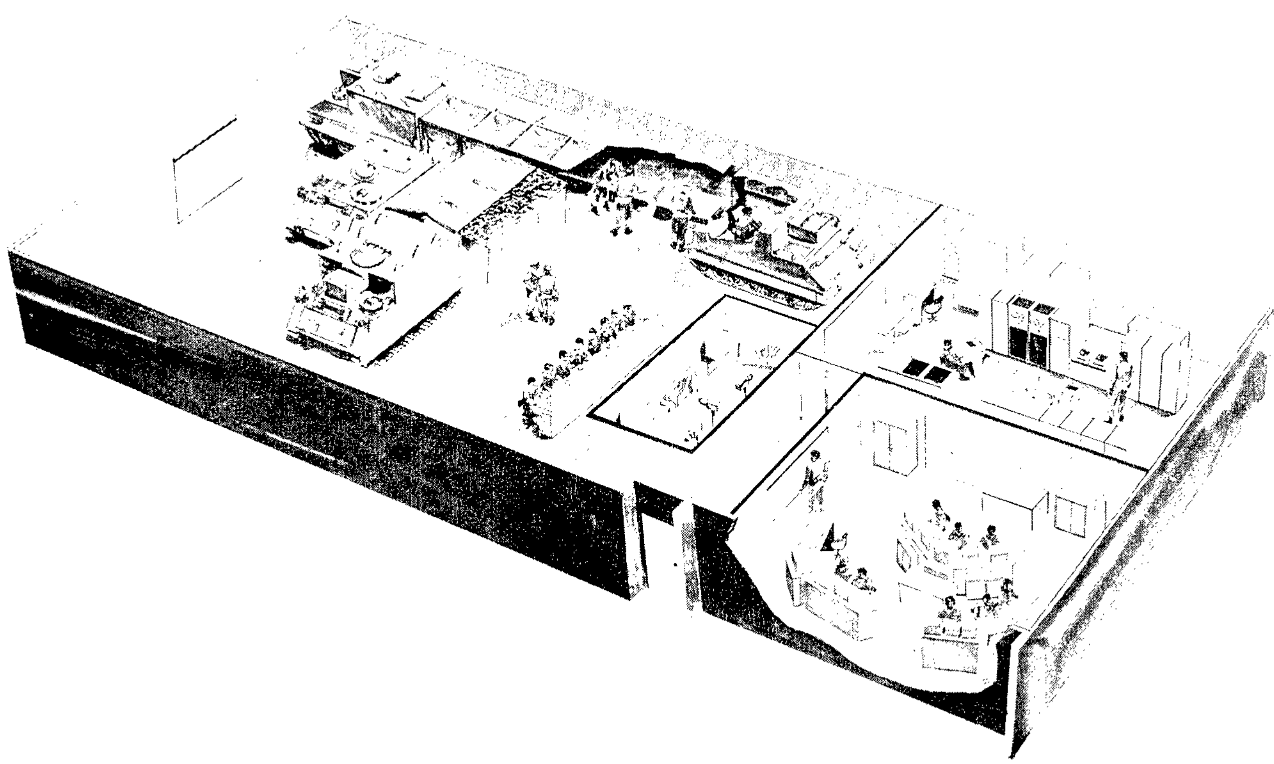
The first graduates of the MK 113 MOD 10 operator course trained on Device 21B63 experienced its effectiveness. Although the 21B63 was developed for the MK 113 MOD 10 fire control system, the basic design (all instructional aspects are provided by the computer program) allows the concept to be applied to any system having computer-driven display consoles.

A second unit of Device 21B63 is scheduled to become operational in October 1977 at Naval Submarine Training Center (Pacific), Pearl Harbor, Hawaii. Device 21B63 was designed and developed by Hughes Aircraft Company, Fullerton, California, under contract with the Naval Training Equipment Center.

Instructor Area, Device 21B63

Combined Arms Tactical Training Simulator (CATTS) Device 16A3

By Frederick F. Herold, Project Engineer
Land Warfare Trainers Systems Branch

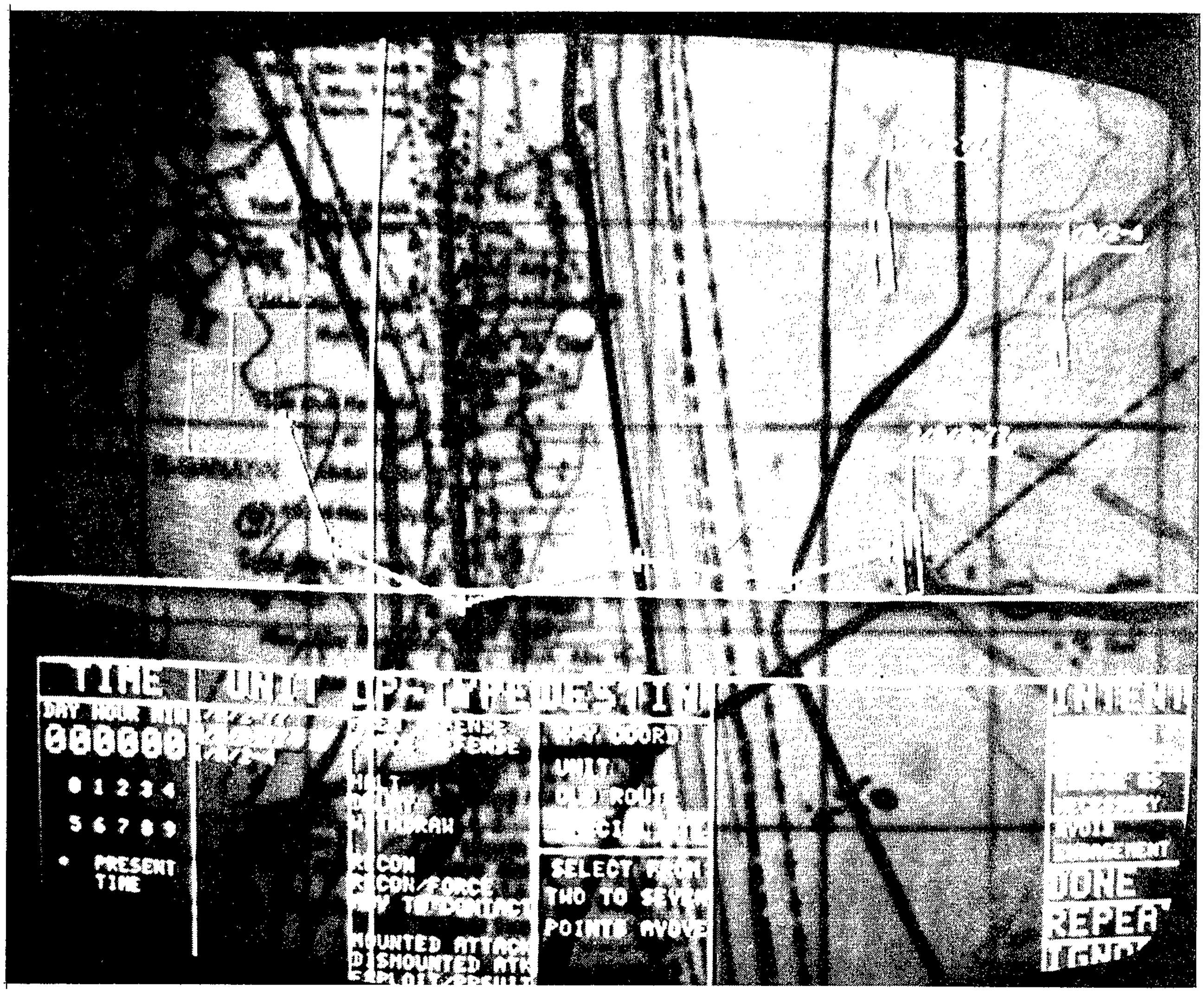


Overall View, Device 16A3

The Combined Arms Tactical Training Simulator (CATTS) is a complex interactive computer simulation model that simulates real-time ground combat tactical operations to train battalion commanders. The system was originally installed at Fort Benning, Georgia in March 1975 for test and evaluation and then relocated to US Army Command and General Staff College, Fort Leavenworth, Kansas in December 1975.

Device 16A3, a Project Manager for Training Devices (PM TRADE) project, was developed by TRW Defense and Space Systems Group, Redondo Beach, California for the Army under contract with the Naval Training Equipment Center.

Player area is a mockup of a tactical operation center (TOC) fully equipped with the normal complement of combat communication equipment for the battalion commander and his staff. Battalion orders are communicated to subordinate commanders, and reports are received from subordinate, support, and higher level commanders. The trainee (battalion commander) is assigned a tactical mission which could be to defend an area or to mount a coordinate attack. Maps of the combat area with tactical symbol overlays provide the coordinated positions of his combat, combat support, and combat service support units and known enemy positions at the initialization of the tactical exercise. Tactical symbol overlay information is manually updated by the battalion staff based upon communication reports of the tactical situation from subordinate, support, and higher level commanders.



Controller Station Color TV Monitor, Device 16A3

Each color television camera views an identically scaled (1:50,000) combat area map and displays the map area viewed on its assigned controller station color television monitor. Each controller station has a camera control (pan, tilt, zoom) for viewing any region of the combat map. The computer senses the different map areas being viewed by each camera, and each controller station can activate graphic function control(s) to request computer generated tactical symbol overlays on its map displays for units, sensors, weapons, minefields, and fire impacts in the viewed area. The tactical information overlayed is selectively increased or decreased as graphic function controls are activated or deactivated. The data base contains the area (width, depth) in meters that an operational unit would occupy and the computer generated tactical symbol overlayed is scaled according to the map scale and the specified unit area. Tactical symbols of the enemy forces are displayed in red and the United States forces are displayed in blue. The controller can zoom in to examine close-up the tactical situation and the computer will automatically change the tactical symbol overlays to reflect the expanded limited area being displayed. The computer updates the tactical information once a minute.

The command and control subsystem allows the controllers to interactively order air strikes, artillery fire, antiaircraft fire, preplanned missions, maneuver units, and change weather conditions and control measures. The command function controls on each controller station specifies the menu to be displayed in the bottom third of the color television monitor. The controller using the Graf Pen and the analog tablet cursor selects from the menu the actions to be implemented by the computer. Selection of **DONE** in the lower right hand corner results in the menu deletion and execution by the computer.

The controller area has three identical independent controller stations. One controller station acts as the enemy force commander and controls its tactical operations. Two controller stations assigned to the trainee (battalion commander) represent subordinate ground unit commanders and fire support (artillery, air) commanders. Each controller station has a color television monitor, function control panel (graphics, command, camera) Graf Pen and analog tablet, communication control panel (simulates 16 radio networks), alphanumeric CRT display, and a hard copy printer. The alphanumeric CRT display provides computer generated alert messages of unit changes occurring each minute in the combat situation. These unit messages specify starting to move, halting, detection of enemy unit, encountering minefield, receiving fire, firing, casualties (equipment, personnel) and low ammunition or fuel. These are conditions that the commanders of operational combat units would encounter and report to the battalion commander. The controller acting as commanders of these units reports the alphanumeric display information to the trainee via the simulated radio networks. The hard copy printer will provide a printout of the current alphanumeric display information upon controller command.

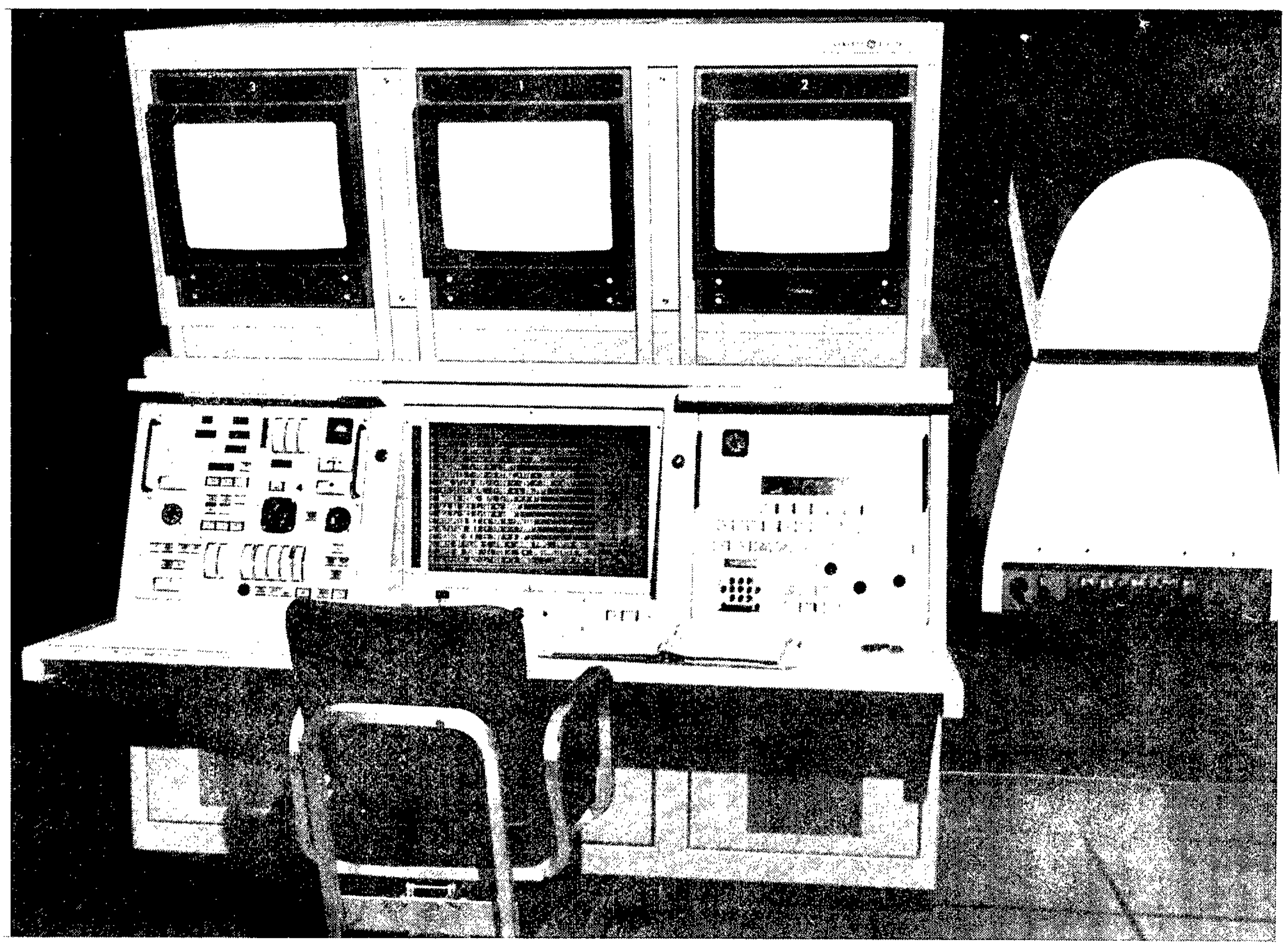
Overall control of CATTS is accomplished by the Xerox Sigma 9 Model 3 computer system with 128K (32 bit) memory and peripheral equipment such as three 86MB disk units, two magnetic tape units, card reader, line printer, ASR-35, and a Ramtek graphic display system (GX-100).

The heart of the CATTS system is the computer, mathematical models, and the data base files. The computer, which is responsible for the activities of movement, sensing, fire support, and engagement, provides a dynamic tactical situation assessment every minute by updating unit tactical symbols overlayed (superimposed) on the controller's map displays and the automatic alert messages generated. The modelling of a battalion level combat conflict requires every significant occurrence to be modelled mathematically in order to handle such problems as: (1) aircraft flying through artillery fire could result in aircraft loss, (2) artillery firing short of the NO FIRE LINE, (3) direct fire weapons will not fire at primary or secondary targets out of weapon range or if a friendly unit is in line of fire, and (4) personnel-man weapons based upon weapon priority (tank, antitank, mortar, machinegun, rifle). The multiple subroutine simulation programs evaluate many variables in determining the status of an activity during each minute update time frame. The ground movement subroutines evaluate the movement rates of the different vehicles in the movement column; fuel available; weather condition (day, rain, fog, night, moon); surface conditions (road, cross-country, soil, slope, vegetation); obstacles (minefields, river); fire suppression; and engaged and movement command (RECON and avoid engagement, MOVE TO CONTACT and engage). Attrition of friendly and enemy forces is calculated on many variables including concentration of force, deployment of forces, and weapon types. Approximately 30 data base files include 99 units (friendly/enemy) and 80 (ground/air) weapon types. The digitized terrain (soil types, slopes, elevation, relief, vegetation, rivers, roads, swamps) files represent a 2,700 square kilometer combat area. Elevation data are every 25 meters for a total storage of 4,320,000 elevation points.

Tactical exercises of four hours or less are recorded on disk storage. The 20 channel magnetic tape recorder stores the simulated radio communications for the exercise. Replay of the exercise on the controller's CRT monitors is synchronized to the communication recordings and provides critique capability. Replay may be started or stopped at any desired game time minute to discuss critical decisions made. The trainee (battalion commander) can see the results of his tactical decision situation with new tactical decisions inputted to show the results of these new tactical decisions. Air and ground mobility have added new dimensions to the rates of movement and flexibility in the tactical situations. This reduction in time and complexity of the changing tactical combat situation increases pressure and stress upon the battalion commander and his staff in limiting alternates considered in planning, making decisions, and communicating commands.

Computer Generated Image Visual System for TA-4J OFT Device 2B35

By Jimmy H. Burns, Acquisition Director
Attack Trainers Branch



Instructor Console, Device 2B35

The Computer Generated Image (CGI) Visual System, Device 2B35, provides an out-the-window wide-angle (60° vertical x 210° horizontal) full-color visual scene for the TA-4J Operational Flight Trainer (OFT), Device 2F90. The simulated visual environment includes a naval air station and the surrounding landscape, a weapons delivery target area, the aircraft carrier, USS Lexington, and a TA-4J aircraft for formation flying. The effects of limited visibility, fog, clouds, and lighting (day/dusk/night) are simulated. The contents and characteristics of the visual environment can be programmed to meet changing training requirements. The system is currently being used in the familiarization phase of advanced jet training at NAS Chase Field, Texas and NAS Meridian, Mississippi.

The requirement for a visual system for undergraduate pilot training (UPT) has been under study since 1970, and in 1971 Naval Training Equipment Center procured an advanced development model (ADM) visual system from the General Electric Company. The ADM was installed at NAS Kingsville, Texas in late 1972 and a series of evaluations of the system was initiated. The evaluations aided in identifying training tasks which could be accomplished using visual simulation and in refining the definition of performance parameters required by CNATRA for UPT. The results of the evaluations were used to specify the performance requirements for Device 2B35.

In June 1974 a contract was awarded to General Electric Company, Daytona Beach, Florida for one Device 2B35, CGI Visual System, and an option for a second system was exercised in June 1975. The first unit of Device 2B35 became operational at NAS Chase Field in November 1975 and the second unit at NAS Meridian in June 1976. Visual environment data base development continued until September 1976.

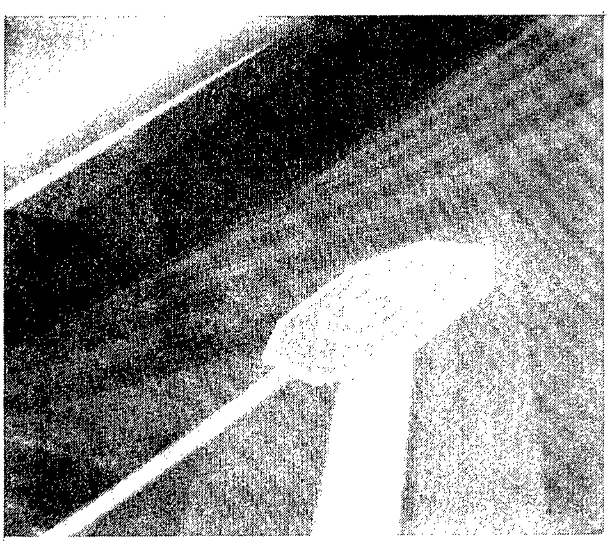
The system consists of three major elements: (1) a display subsystem, (2) a special-purpose image processor, and (3) a general-purpose computation system.

Display Subsystem

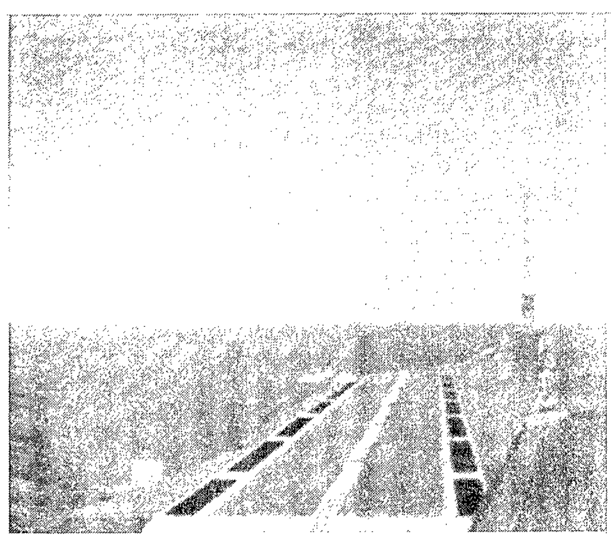
The visual scene viewed by the pilot is formed on three flat rear projection screens which are mounted on the floor and butted together at the edges to surround the front half of the cockpit. Three television projectors are directed at the screen from the rear to provide a continuous visual scene throughout 60° of elevation and 210° of azimuth. Continuity of the visual scene between adjacent screens is maintained by video cursors and photoelectric sensors which prevent image drift. The visual presentation is repeated at the instructor's console using three television monitors.

Image Processor

The heart of the system is the image processor, a high-speed special-purpose computer housed in seven standard equipment cabinets. The purpose of the image processor is to compute a two-dimensional view of the simulated three-dimensional world from a digital data base which describes the visual environment. The image is computed 30 times per second in the form of



Weapons Target NAS Meridian



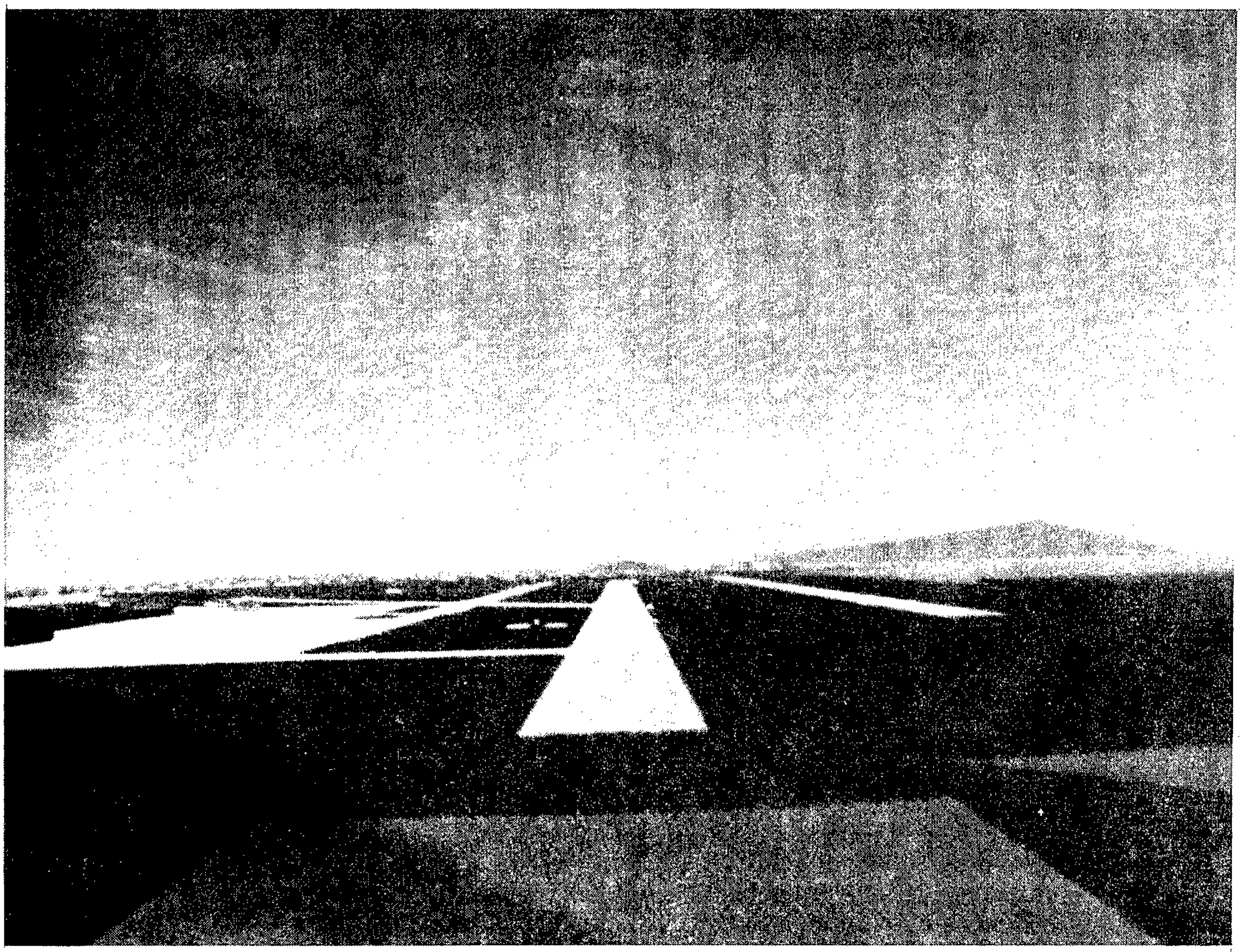
USS Lexington

standard color television video signals for 512 picture elements along each of 485 active horizontal raster lines for the three display channels.

General-Purpose Computation System

Overall control of the system, data management functions, and initial simulation computation are performed by a general-purpose computation system consisting of a PDP-11/50 digital computer and related software, interface equipment, and peripheral devices. During realtime simulation the general-purpose computer receives aircraft position and attitude data from the Device 2F90 simulation computer and computes pilot eyepoint data for use by the image processor. Operator control inputs such as visibility, fog and cloud data, and position and attitude data for the simulated lead aircraft and the aircraft carrier are also processed by the computer.

The PDP 11/50 is a 16-bit word size, general-purpose digital computer manufactured by Digital Equipment Corporation with an integral floating point processor and 32,768 words of memory. A disc file provides off-line storage for all system software and a TU 10-EA tape transport provides backup capability and library storage. A CR-11 card reader is the basic input device for programming changes. The output device for data base update, diagnostic data, and listing is an LP 11-JA line printer. Two KSR-35 teletypewriters located by the instructor's console and near the central processing unit provide system control for training and maintenance. DR-11B and DR-11C, DMA Interface Units, permit data communication with the special-purpose image processor and Device 2F90 simulation computer.



Final Approach NAS Chase Field

System Operation

After the system is turned on, daily adjustments performed, and the appropriate programs loaded, the visual system is controlled from the Device 2F90 instructor console using abbreviated plain language commands entered via a teletypewriter. A typical command is **TR** to enter Training mode, which slaves the Device 2B35 eyepoint to the Device 2F90 OFT position and attitude. Visual parameters controlled by the instructor include background color, color and intensity of fog or cloud layers, sky colors, and data base selection.

Environment Data Base

The characteristics of the simulated visual world as stored by the system are referred to as the environment data base. The data base is a numerical representation of the simulated environment organized in a form convenient to the special-purpose hardware. CGI visual systems depict terrain features as combinations of convex objects which are defined by plane surfaces bound by straight lines (edges). System capacity and other capabilities are commonly defined in terms of edges and surfaces. Data bases are prepared by coding the coordinates (X, Y, Z) of the vertices of each surface and the color of each face (surface) on punched cards. Additional environment characteristics such as relating vertices to particular surfaces and objects and the location and characteristics of point objects and lights are also included. The data is then processed off-line on the general-purpose computer using data base compiler programs to generate the environment data base which is stored on magnetic disc. A single disc will accommodate up to four environments and the real-time simulation program. The system includes complete facilities for generation or modification of environment data bases.

Maintenance Diagnostics

The special-purpose hardware contains approximately 900 circuit boards (approximately 30,000 integrated circuits). Under the control of maintenance personnel the diagnostic programs sequentially test each functional unit of the special-purpose hardware and inform the operator of the results of each test via hard copy printouts. The diagnostics also permit the operator to insert standard data patterns at various points in the system and to examine intermediate results of the computations in order to further isolate malfunctions. Test and alignment patterns are provided for the display subsystem.

The special-purpose hardware incorporates a digital display and entry panel to permit examining or changing the contents of the registers and memories of the special-purpose hardware in a manner analogous to the use of the maintenance panel of a commercial computer. The manufacturer's standard diagnostic software is provided with the general-purpose computer system.

Salient Features

Table 1 summarizes some of the features of Device 2B35 and, where appropriate, related characteristics of the advanced development model are listed for comparison. Noteworthy features are described briefly below:

Field of View — Device 2B35 provides a continuous scene throughout a 60° vertical by 210° horizontal field of view, far larger than other visual systems being used for training.

Edge Smoothing — Horizontal and vertical edge smoothing techniques are used to minimize the stair-step appearance of slanting lines in the scene and reduce scintillation.

Level of Detail — Utilization of the system's image processing capacity is optimized by increasing scene complexity (level of detail) for nearby objects and decreasing complexity or eliminating distant objects. Up to eight levels of detail may be used to minimize abrupt changes in the visual scene.

Point Objects and Lights — The visual scene within the field of view may contain up to 1,000 simplified point objects in addition to the normal 1,000 edge image processing capacity. The point objects may be used as cultural lights in a night scene or as texture objects in a day scene to supplement velocity and turning cues.

Improved Environment Data Bases — Increased system capacity permitted the development of environment data bases which are more effective for training than were available with the ADM visual system. More visual cues are available through a larger portion of the flight environment.

TABLE 1. COMPUTER GENERATED VISUAL SYSTEM CHARACTERISTICS

SYSTEM CHARACTERISTICS	DEVICE 2B35	DEVICE 2F90 ADM
IMAGE PROCESSING:		
Maximum environment size	10,000 edges	2,200 edges
Scene update rate	30 Hz	30 Hz
Moving models	3 models	2 models
Levels of detail	8 levels	4 levels
Total real-time objects per scene	256 objects	63 objects
Edges per scene	1,000 edges	500 edges
Special-purpose lights	30 lights	none
Maximum edge crossing/raster line-system	506 edge crossings	384 edge crossings
Maximum edge crossing/raster line-channel	256 edge crossings	128 edge crossings
Variable size point lights/point sources	1,024 lights/sources	none
Digital edge smoothing	yes	no
Variable fog/fading	yes	yes
Aerial perspective	yes	yes
Moving clouds (penetration and break-out)	yes	no
Overtemperature protection	yes	no
DISPLAY SYSTEM:		
Floor mounted	yes	yes
Number of channels	3 channels	3 channels
Field of view (horizontal)	$210^{\circ} (\pm 105^{\circ})$	$180^{\circ} (\pm 90^{\circ})$
Resolution (horizontal) arc minutes/picture element pair	19 arc-min	20.4 arc-min
Field of view (vertical)	$60^{\circ} (\pm 30^{\circ})$	$60^{\circ} (\pm 30^{\circ})$
Resolution (vertical) arc minutes/line pair	17 arc-min	19.2 arc-min
Contrast ratio (checkerboard)	25:1	--
Highlight brightness (center of screens)	2.4 footlamberts	2.4 foot-lamberts

TABLE 1. COMPUTER GENERATED VISUAL SYSTEM CHARACTERISTICS (CONT)

SYSTEM CHARACTERISTICS	DEVICE 2B35	DEVICE 2F90 ADM
DISPLAY SYSTEM:		
Geometric distortion	less than 1%	--
Automatic edge match control	yes	no
FAULT-ISOLATION DIAGNOSTICS/ CALIBRATION:		
Built-in test hardware (unified data bus)	yes	no
Computer controlled diagnostics	extensive	limited
Display system calibration patterns	yes	no

Training Research

360° Closed Circuit Television

By John J. Kulik, Electronics Engineer
Electronics and Acoustics Laboratory

Many training systems and simulators require a visual presentation on a very wide field-of-view screen to enhance the realism of the scene and to make the trainee feel **part of the scene.** The Electronics and Acoustics Laboratory of the Naval Training Equipment Center was tasked to do research work toward producing a 360° closed-circuit television system. A simple approach to building a 360° panoramic television system is to set up a number of flat screens on a hexagonal or octagonal format with each screen showing a scene picked up by its own camera. Figure 1 shows one such setup. Such an approach is not only straightforward from a technical standpoint but is cost-effective as well. The cost of visual systems for aircraft type simulators can be very high, which is justified by the high unit price of the aircraft being simulated. For tank or truck driver, gunnery, and small boat trainers, an inexpensive visual system is sufficient to provide cost-effective training.

To make a multiple channel 360° system work effectively, the operational problems to be solved are:

- A smooth background scene transition from screen-to-screen must be produced, and
- Targets capable of motion across the entire 360° scene must be produced.

These problems are translatable into technical problems which require research. For a smooth background scene transition, a way must be found to remove the nonlinearities normally associated with the driving voltages used to drive a CRT electron beam across the face of the tube, or to make the nonlinearities the same from one tube to its neighbors at the transition points. A circuit was designed, built, and tested which produced a segmented driving voltage (5 segments), the slope and length of each segment being individually adjustable. Figure 2 shows a nonlinear ramp and a segmented ramp (5 segments). The circuit was developed to allow segmenting of both horizontal and vertical ramps for maximum flexibility. In order to test the circuit, a television frame was separated into its component fields and every other field was scanned in the vertical mode. These were inserted between the horizontally scanned fields. The result was a television picture composed of a horizontal and vertical scanned picture on a television display. The two pictures can be seen quite clearly in figure 3. The ramp segments (5 segments per ramp) were controlled in slope by potentiometers and in figure 3 the potentiometers were set for maximum misregistration of picture elements. Then, the potentiometers were reset to produce registration of the picture elements so that the **horizontal** and **vertical** pictures would be coincident. Figure 4 shows the coincident pictures. The test demonstrated that a great deal of control is possible in matching pictures and that the segmented ramps could be used for matching contiguous displays for a smooth scene transition across a number of displays.

In order to match scenes at a transition point, the last segment of one driving voltage and the first segment of its neighbor are adjusted until the picture elements are placed so that a smooth background scene results. In order to maintain a smooth transition once it is achieved, very stable circuits are required, or a microcomputer can be used to sense any drift occurring with proper controls to keep the system within specified tolerances.

A decision was made to use vertical scanning on the system since matching 500 to 1,000 lines seemed like a difficult problem to solve. This, however, led to a new problem. Between each television field, time is reserved for control signals with the result that six black bands appear when the displays are synchronized in phase. The bands can be removed by introducing delays into the synchronizing signals so that when one display turns off, its neighbor turns on, producing continuous video around the screen. It was found that all commercial displays have specifications that allow a maximum of 12 displays to be used for a 360° system with system resolution dependent upon the number of displays chosen for the final system.

To produce a target capable of motion across the entire 360°, a target camera is used and its

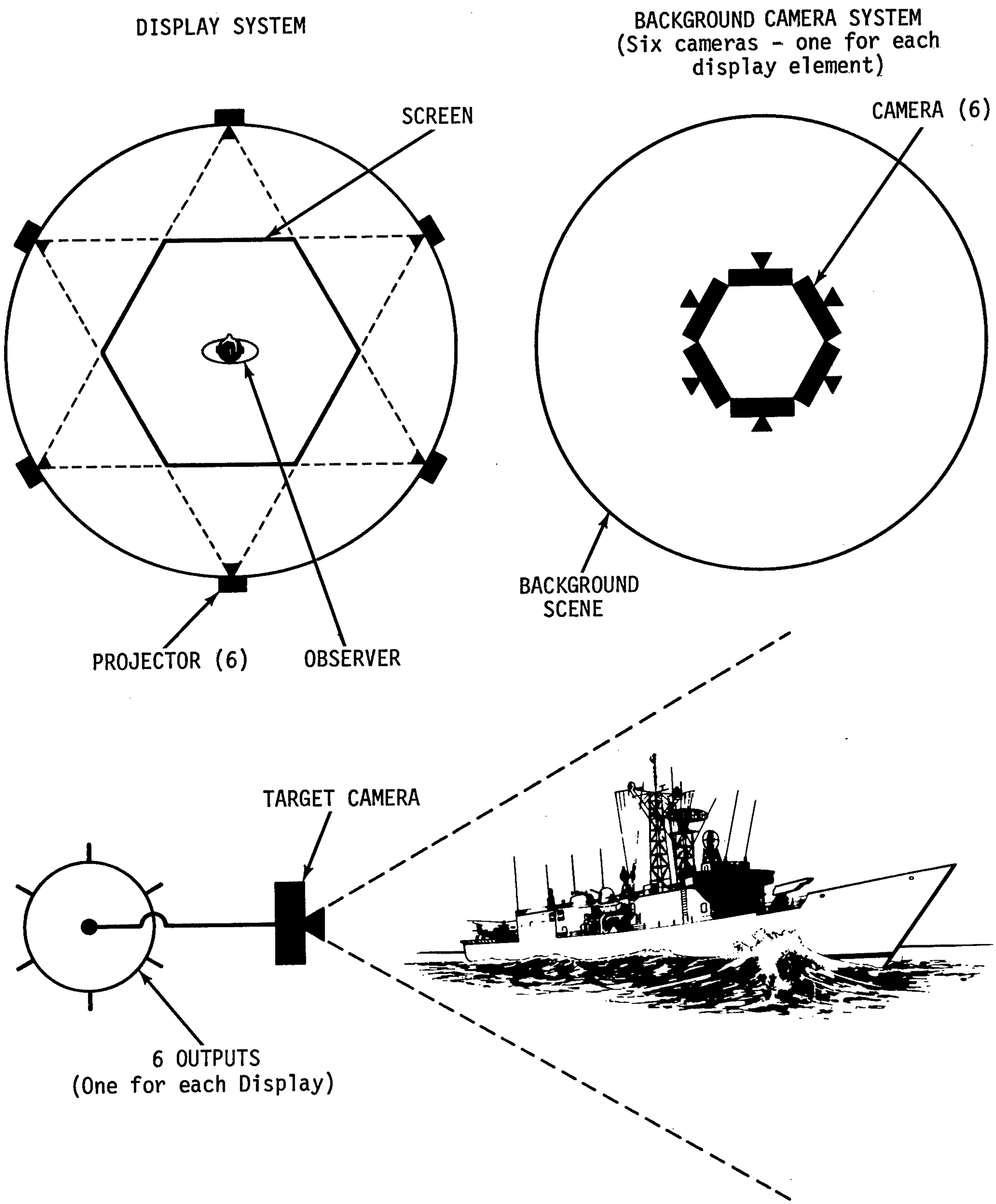
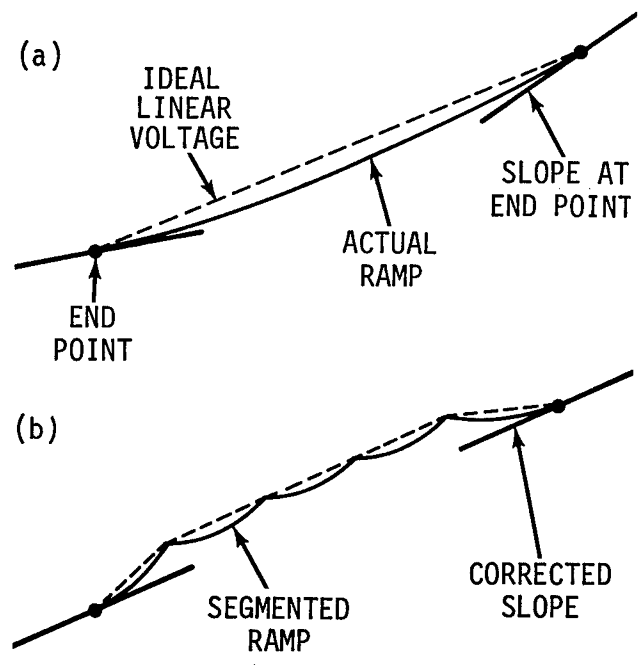


Figure 1. System configuration showing target camera with target video available to all display.

video is presented to all (6 or 8) display components simultaneously as in figure 1. Blanking circuitry is used with a computer to blank out the target video (which would occur on all displays) except where it is supposed to occur. When target video is present, the background video is switched off and target video switched on so that a target in a background is displayed. Delay of synchronous signals to the camera relative to those of the display produces motion of the target across the screens. The circuitry can be thought of as a sliding electronic gate producing a target moving across the 360°.

The techniques for a 360° system have been proven in the Electronics and Acoustics Laboratory, and recommendations have been made to construct an advanced development model of a shiphandling trainer based on the results of the research described.

The laboratory believes that cost-effective trainers can be constructed for relatively low unit cost vehicles by using the techniques developed and tested. NAVTRAEQUIPCEN Technical Report IH-268, Nonprogrammed Multiple Channel Panoramic CCTV System, (expected publication date, July 1977) describes in detail the work discussed in this paper.



(a) Upper sketch shows a typical non-linear driving voltage (ramp) with different slopes at the end points.

(b) Lower sketch shows a segmented ramp adjusted so that the end points have identical slopes.

Figure 2.

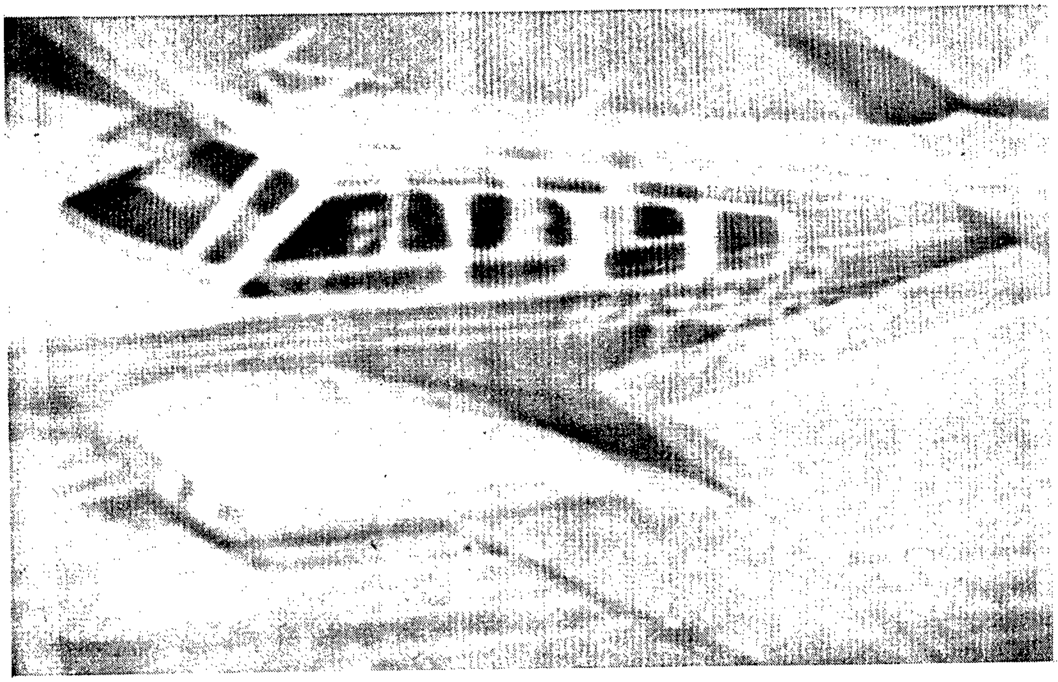


Figure 3. Horizontal and vertical scanned picture of aircraft with potentiometers set to show divergence of picture elements.

Figure 4. Same picture as in figure 3 but with potentiometers set for picture coincidence.

Training Analysis

Microfiche as a Training Medium

By William A. Rizzo, Psychologist
Training Analysis and Evaluation Group

Background

The technological complexity of Navy weapons systems has caused a burgeoning volume of support documents in the form of maintenance manuals, software files, and training materials. Paper documentation, in particular, has reached a critical mass with respect to storage space, handling, and updating requirements. As a partial solution, micrographics are being used to overcome data storage and retrieval problems and to reduce the expense of producing and updating these materials. For example, the Navy Shipboard Microfilm Program will screen over 90,000 technical manuals for micropublishing. Those considered to be usable and cost-effective in the microfiche format will be converted during this five-year program.

Concurrently, the microfiche medium is being considered as an alternative instructional delivery system for onboard training. Recent studies have indicated that microfiche may be a viable training medium based on economy, ease of handling, and storage. To assess the feasibility of this concept, the Chief of Naval Education and Training has tasked the Training Analysis and Evaluation Group (TAEG) to compare the use of microfiche with traditional media. This work is being performed for the David W. Taylor Naval Ship Research and Development Center as part of the Naval Technical Information Presentation Program (NTIPP). TAEG is conducting a series of studies to evaluate the efficiency of the microfiche medium as opposed to alternatives with respect to human factors, economics, and attitudinal considerations. The work effort in the first phase of this program examined microfiche reader design, the feasibility of using color microfiche with audio, and the effects of microfiche versus hard copy on technical training. These three studies are described below.

Evaluation of Microfiche Reader Design

The initial study evaluated a cross section of microfiche reader types with respect to their ease-of-use by Navy enlisted personnel in loading/unloading microfiche and searching for specified frames. Sixty Navy recruits performed a search task to simulate the branching requirements of programmed instruction. Five microfiche indexing methods, using four types of readers, were rank-ordered on ease-of-use in terms of times required to load/unload and complete a branching task on 16 microfiche. It was found that the typical Navy recruit can, with a minimum of instruction, use any of the microfiche readers tested. The grid map/pointer indexing system, available on many commercial readers, was found to be the most efficient and this type of reader/indexing system was recommended for use in Navy training. Details of this study are found in TAEG Report No. 35, An Evaluation of Microfiche Reader Types for Use with Programmed Instructions, dated August 1976.

Sound/Fiche Versus Sound/Slides

The second investigation demonstrated the concept of using color microfiche with audio as an alternative to sound/slides at the Basic Electricity and Electronics (BE&E) School, Service School Command, Orlando, Florida. The purpose of the demonstration was threefold: (1) to determine the feasibility of this innovative medium, (2) to evaluate user reaction to sound/fiche, and (3) to solicit user recommendations for refining sound/fiche presentations. Twenty instructors and 20 trainees at the BE&E School reviewed four sound/fiche programs which were direct adaptations of sound/slide programs currently used at the school. The subjects were asked to compare the sound/fiche and sound/slide programs regarding operational factors, physical comfort, study habits, and attitudes. The results indicated that the sound/fiche concept was positively received by both trainees and instructors. Economic analyses comparing alternative A/V systems suggest that sound/fiche may be a less expensive instructional medium than sound/slides. TAEG Technical Memorandum No. 77-2, Demonstration and Evaluation of a Microfiche-Based Audio/Visual System, dated April 1977, presents the details of the study including the cost analyses and a comprehensive list of recommendations.

Microfiche Versus Hard Copy

The third study, recently completed, assessed the effectiveness of microfiche versus hard copy for BE&E training. An experimental group of 30 trainees completed the BE&E curriculum using microfiche exclusively. The course is comprised of 14 modules of instruction requiring approximately five weeks to complete. Performance data have been collected and are currently being analyzed to compare completion times of the experimental trainees with times for trainees receiving instruction with hard copy materials. The two groups of trainees were matched on the basis of Armed Services Vocational Aptitude Battery test scores. Upon completion of training, all experimental trainees were interviewed to obtain opinions regarding operational factors, the microfiche training modules, physical comfort, and attitudes toward microfiche training. Recommendations for optimizing the use of microfiche for training were also sought. The experimental trainees favored using microfiche over hard copy; their comments dispelled commonly held notions that prolonged, concentrated viewing of microfiche is objectionable and causes eye fatigue. Detailed results of this study, including cost analyses, will be published subsequently in a TAEG Report.

Additional Studies

Three related studies are planned in support of NTIPP. These envisaged TAEG efforts are outlined below.

- The microfiche reader design evaluation and the BE&E training effectiveness study will be replicated using the Personalized Portable Micromedia Display System (PPMDS), a hand-held microfiche reader being developed by the David W. Taylor Naval Ship Research and Development Center. Performance of PPMDS units will be evaluated for potential use within NTIPP for onboard training.
- Optimized training material formats will be developed for microfiche using computer-aided authoring techniques. These formats will be designed to maximize learning and retention of information. The Aerographer Mate School, Lakehurst, New Jersey is the planned test site to evaluate the learning formats using the microfiche medium. Performance on a weather symbol, paired-associate learning task will be evaluated using alternative presentation formats.
- Expanded learning format studies using microfiche will be conducted in an onboard training environment. Use of these formats will be evaluated in the training of equipment operation and maintenance procedures.

The total TAEG effort will provide NTIPP with a comprehensive evaluation of mirofiche-related hardware and software for potential use in Navy schools and for onboard training.

New Publications

The following publications have been released since the January 1977 issue of the Training Support Developments:

In order to provide technical support data for training equipment concurrently with receipt of the training equipment, a preliminary or manuscript copy of the training equipment support handbook(s) is usually furnished to the training equipment custodians at that time. When the final training equipment support handbook(s) is printed, copies of the finals are automatically forwarded to training equipment custodians, and preliminaries should then be destroyed.

Holders of any NAVTRAEQUIPCEN training equipment, who have not received the related final publications, as listed on pages 25 and 26 are advised (1) to ask their station receiving office whether the publication has been received, and (2) if the publication cannot be located aboard the station, to ask their local supply officer to order a copy of it as a Cognizance "I" publication, in accordance with NAVSUP Publication 2002, Navy Stock List of Forms and Publications, Section V, Part B.

Device No.	Publication Title	Publication No. and Date	Pub Scty Class
2C57	Op & Maint HB for Suitcase Emergency Procedures Trainer for AV-8A Aircraft	NAVTRADEV P-4287, Feb 77	U
2F64B	Maint HB for SH-3D Helicopter WST	NAVTRADEV P-4130, Vols I-III, Oct 76	U
2F64B	Change 2 to MRC for SH-3D Helicopter Weapon System Trainer	NAVTRADEV P-3542, Oct 76	U
2F90	Change 3 to Util HB for TA-4J Aircraft OFT	NAVTRADEV P-3569-R3, Nov 75	U
2F90	Change 4 to Maint HB for TA-4J Aircraft OFT	NAVTRADEV P-3566-R4, Vols I-II, Nov 75	U
2F90	Change 4 to Programming Manual for TA-4J Aircraft OFT	NAVTRADEV P-3570, Vols I-III, Nov 75	U
2F90	Suppl to Maint HB for TA-4J Aircraft OFT	NAVTRADEV P-4134, Vols I-III, Nov 75	U
6E10	Op & Maint Guide for Aviation Wiring Trainer	NAVTRADEV P-4267, Jan 77	U
6E11	Op & Maint Guide for Aviation Troubleshooting Trainer	NAVTRADEV P-4268, Jan 77	U
7B1/1	Op & Service Manual for Oscillator 204C/204D	NAVTRADEV P-3865, Oct 76	U
7B1/1	MRC for Electromagnetic Stimulator	NAVTRADEV P-3980, Nov 76	U
7B1/1	Op & Maint HB for AG500 & AL500 Recorder/ Reproducer	NAVTRADEV P-3866, Sep 71	U
7B1/1	Instr Manual for Type 1390-B Random-Noise Generator	NAVTRADEV P-3867, Oct 76	U

Device No.	Publication Title	Publication No. and Date	Pub Scty Class
7B1/1	Vendor Handbooks for Electronic Stimulator	NAVTRADEV P-3869, Vols I-IV, Oct 76	U
7B1/1	Maint HB for Electronic Stimulator	NAVTRADEV P-3979, Oct 76	U
10A3/1 & 10A3/2	Op & Maint Manual for Synchro Termination Unit	NAVTRADEV P-4007, Apr 75	U
10A3/1 & 10A3/2	Op & Maint Manual for Model 7232-04 DF Interface Unit	NAVTRADEV P-4077, Jul 76	U
10A3/2	Op & Maint Manual for Interactive Adapter Unit Control & RF	NAVTRADEV P-4082, Jun 74	U
10A3/1 & 10A3/2	Op & Maint Manual for Digital to Video Converter & Switching Unit	NAVTRADEV P-4083, Jun 74	U
10A3/1	Op & Maint Manual for RF Combiners	NAVTRADEV P-4053, Feb 76	U
14A2F	MRC for Surface Ship ASW Attack Trainer	NAVTRADEV P-3986, Sep 75	U
14A2F	Suppl to MRC for Surface Ship ASW Attack Trainer	NAVTRADEV P-3986-S1, Sep 75	C
14B44	Change 1 to MHB for P-3C DIFAR Operator Trainer	NAVTRADEV P-3879-2-C1, Nov 76	U
16C53A & 16C54	Op & MHB for Amphibious Supporting Arms Evaluator	NAVTRADEV P-4224, Sep 76	U
16C53A/54	MRC for Amphibious Supporting Arms Evaluator	NAVTRADEV P-4226, Sep 76	U
	Training Support Developments	NAVTRADEV P-1300-66, Jan 77	U

TECHNICAL REPORTS

Publication Title	Publication No. and Date	Pub Scty Class
Evaluation of Human Relations Training Programs	NAVTRAEQUIPCEN 75-C-0076-1, Jan 77	U
Aviation Wide-Angle Visual System (AWAVS) Design Analysis Report	NAVTRAEQUIPCEN 75-C-0009-1, Apr 75	U
A-6E Systems Approach to Training Phase I Final Report	NAVTRAEQUIPCEN 75-C-0099-1, Feb 77	U
A Study of the Effectiveness, Feasibility, and Resource Requirements of Instructional Systems Development: EA-6B Readiness Training	NAVTRAEQUIPCEN 75-C-0100-1, Jan 77	U
E-2C Systems Approach to Training	NAVTRAEQUIPCEN 75-C-0101-1, Dec 76	U
Computer Simulation of Fresnel Lens Optical Landing System	NAVTRAEQUIPCEN IH-265, Sep 76	U
Evaluation of the Weaponeer Marksmanship Training Device (Recoil Point of Aim Power)	NAVTRAEQUIPCEN IH-278, Aug 76	U
Color Displays for Training Devices	NAVTRAEQUIPCEN TN-51, Jan 77	U
Errata No. 1 to Color Displays for Training Devices	NAVTRAEQUIPCEN TN-51, Mar 77	U
Status Report of Experimental Research for Phase I Advanced Fire Fighting Simulators	NAVTRAEQUIPCEN TN-54, Jan 77	U
Peri-Apollar 360 Degree Lens Distortion Free Linear Mapping	NAVTRAEQUIPCEN TN-55, Feb 77	U
Delay of Visual Feedback in Aircraft Simulators	NAVTRAEQUIPCEN TN-56, Mar 77	U

Technical reports are distributed to selected addressees and are available through the Defense Documentation Center (DDC), Cameron Station, Alexandria, VA 22314, upon announcement in DDCs monthly Technical Abstract Bulletin (TAB) of listing in the DDC Cumulative Index. Unclassified, unlimited technical reports may be purchased from the National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. In general, technical reports are not supply items, and are not stocked by the Naval Training Equipment Center, nor in the Navy supply systems.

Issuance of this periodical approved in accordance with Department of the Navy Publications and Printing Regulation, NAVEXOS P-35.

Reviewed and Approved, 30 June 1977

W H Smith

(Reviewing Official)

Please route this Bulletin to all personnel concerned with training devices.